Joint CQSE and CASTS Seminar

Special Seminar
Jun. 28, 2017 (Wednesday)

TIME Jun. 28, 2017, 14:00 ~ 15:00
TITLE Localization of electrons in core-shell nanowires
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Abstract

With recent technologies thin three-dimensional nanowires of 100 nm diameter or less, and length up to tens of µm, can be fabricated with semiconductors. They can have uniform cross section when they are made of a single material, but they can also be a core of one material surrounded by a layer of another one. The later structure is called core-shell nanowire and can be seen as a radial version of the classical planar heterojunction. In this presentation three types of electronic localization in such nanowires will be discussed, together with their physical consequences.

1. With an insulating core and a thin conductive shell the charge carriers become radially localized and the electronic transport occurs through the shell like through the wall of a tube. Consequently, in the presence of a longitudinal magnetic field, the angular motion of the electrons leads to loops which generate conductance oscillations similar to the Aharonov-Bohm effect.

2. In a magnetic field perpendicular to such a tubular nanowire an angular localization develops along the directions lateral to the magnetic field, where so-called called snaking orbits are created. The electron distribution has maxima on the lateral sides of the tube and the electronic current flows along these regions. Recent experiments identified Aharonov-Bohm-like oscillations along the longitudinal contour of the nanowire. Another consequence of this angular localization is the sign reversal of the electric current generated along the nanowire by a temperature bias.

3. Due to the original crystalline structure of the materials used for fabrication, the cross section of core-shell nanowires is most often of hexagonal shape. The third localization mechanism discussed in this presentation is a result of the polygonal transversal geometry. The electrons situated in a thin polygonal shell have the quantum mechanical ground state localized in the corners and excited states localized on the sides. The energy separation between corner and side states depends on the aspect ratio of the shell (thickness vs. radius), and on the sharpness of the corners. It can be as large as 100 meV or more for triangular shells.

Consequences on optical spectra of and on Majorana states in such nanowires will be discussed.